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Blackstone Canal Project

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BLACKSTONE CANAL REDEVELOPMENT

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Abstract

The proposed Blackstone Canal Project aims to revive the culture and economy throughout downtown Worcester, Massachusetts, through the creation of a reconstructed canal. This report explores the potential of integrating ecological goals into the current plan by researching previous projects that have attempted to achieve both ecological and economic goals simultaneously. A group of previous projects was narrowed down to four using certain criteria to determine their applicability to Worcester, and five aspects of each selected project were researched further: economic goals, ecological goals, funding, public involvement, and the outcome of the project. Information collected from the case studies was then examined in terms of its applicability to Worcester, and recommendations were given regarding integration of ecological goals into the Blackstone Canal Project.

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1: Introduction

Ecological services in urban environments can provide necessary functions that would otherwise need to be accounted for by engineered systems. Examples of these services are water regulation and supply, waste treatment, food production, erosion control, and provision of recreation and culture. The value these services provide to humanity is enormous. In addition to facilitating human survival, they lower costs which would need to be incurred elsewhere. Thus, unless cities are willing to replace ecological services, it is necessary to incorporate them into the urban infrastructure.

New urban development often means a loss of the environment and its services. However, this choice between ecological services and infrastructure expansion does not have to be made. Urban development can incorporate ecology into its design. This approach has the potential to achieve multiple objectives: accomplishing the city's desired infrastructure goal while maintaining or improving its previously supplied ecological services, or even providing new services. Development which incorporates ecological services has been labeled green development, and can be defined as "engineered structures (such as water treatment facilities or green roofs) that are designed to be environmentally friendly" (Benedict & McMahon, 2002, p. 7). Integrating ecological services into the urban environment reduces the need for engineered systems, and ultimately counteracts the effects of rapid urban development on the environment.

Despite these benefits, this method of urban development is not often discussed. The majority of urban development projects are undertaken in order to provide economic stimulation, with the focus on new infrastructure, new businesses, or new economic policy. Rarely do environmental services play a profound role in decision-making. However, a city's economic goals can be met while simultaneously achieving environmental benefits. By planning to incorporate ecological services into a design from its inception, many cities have found a mechanism to achieve this (Benedict & McMahon, 2002, p. 15).

The opportunity exists in Worcester, Massachusetts, to embrace these concepts and develop a more sustainable, environmentally-friendly city through the Blackstone Canal Project. The original Blackstone Canal, built in 1827, connected Worcester to Providence. It was a major source of economic stimulation as a result of newfound opportunities for commerce, and it allowed Worcester to thrive for the next 20 years. After the development of railroads, however, Worcester's dependence on the canal for commerce greatly declined, and it was eventually covered and integrated into the city's sewer system.

The main purpose of the proposed Blackstone Canal Project is to attract new businesses and increase tourism, thus stimulating the economy, through the use of a reconstructed Blackstone Canal. Given the need for ecological services in the city, it is possible to incorporate environmental goals into the project. For example, the Upper Blackstone Water Pollution Abatement District plant in Millbury, Massachusetts, is used to treat wastewater from the city of Worcester. The plant is currently experiencing budget cuts, while costs are increasing due to plant improvements and expansion. (Kotsopoulous, 2006) If the city incorporates issues such as this into planning for the Blackstone Canal project, it may be possible to achieve both economic and ecological goals, while additional ecological services could be provided for local citizens. For example, using technological processes available today, it could be possible to treat wastewater or improve the quality of the city's water supply by running it through the reconstructed Blackstone Canal.

The goal of this project was to determine if Worcester can use the canal project to provide ecological services while simultaneously providing a means of economic stimulation. We explored the different ecological services which could be incorporated into the infrastructure, while perhaps avoiding additional costs elsewhere. This was done by researching previous city projects which have used a green development approach, and applying the results of these projects to the proposed plan for downtown Worcester.

2: Background

The goal of this research was to explore the potential of urban regeneration in terms of both economics and ecology. The following chapter contains a compilation of background information necessary to accomplish this goal. It includes a brief history of the original Blackstone Canal as well as background on the recently proposed Blackstone Canal Project. The chapter then focuses on developing the discipline of ecological economics and its various approaches, the concepts behind green infrastructure, and finally, the importance of ecological amenities. The purpose of this discussion is to provide information on the currently proposed project, and then explore different methods of achieving both economic and ecological goals.

2.1: History of the Blackstone Canal

In order to understand the potential ecological services and amenities that could be provided by a reconstructed Blackstone Canal, it helps to know the history of the original canal, and the services it provided. In the early 1800's, after being defeated by the politics of the day decades earlier, the Blackstone Canal was finally approved. Built in 1827 by skilled Irish canal builders, the Blackstone Canal brought unprecedented prosperity to the city of Worcester. During the construction of the canal, a man by the name of Benjamin Wright (1822) was quoted as saying:

> "It is calculated that the expense of transporting on a canal, exclusive of tolls, amounts to ONE CENT a ton, per mile, or one dollar a ton for one hundred miles, while the usual cost of conveyance by land is one dollar and twenty-five cents per hundred weight, or twenty-five dollars a ton for the same distance…A loaded boat can be towed by one or two horses at the rate of twenty-five or thirty miles a day…Canals enable the farmer, the mechanic, and the merchant to convey their commodities to market, and to receive a return at least twenty-four times cheaper than by roads."

Based on this account, it is apparent that the canal made Worcester a much more attractive hub of commerce as a result of the sharp drop in transportation costs which

removed a significant barrier to trade. The canal provided Worcester with an economic advantage for many years, allowing the city to significantly increase in size during its operation ("Dead and Buried," 2002). Starting in the 1830's, the advent of the railroad provided a superior method of transportation and the canal's use as an artery of commerce declined. In the late 1840's, the Providence-Worcester railroad was completed as the canal's replacement and use of the canal came to an end.

While the use of the canal for commerce was important, the canal and its parent river, the Blackstone River, had many other uses during that era. Even after the Blackstone Canal was closed to traffic, it still served a purpose, and continues to do so today. During its era of operation, the residents and businesses of Worcester treated the canal and the river as an open sewer, a place to deposit any and all waste. Waste dumping was widespread, and there were some who even used the canal as a place to bathe themselves or dispose of dead livestock. After the canal was closed, its use as an open sewer continued, and in 1850, then Mayor Henry Chapin called for "construction of ample common sewers, and a more effective mode of draining the city," ("Dead and Buried," 2002) to which the Blackstone Canal would contribute.

The Blackstone Canal's incorporation into the city's sewer system allowed it to provide a valuable service of waste management to the city, even after its original purpose was lost. The canal was able to drain waste and other waste waters, such as runoff from rain, out of the city and into the Blackstone River. Using the canal as a sewer element was not without its costs, however. Homes in areas of lower elevation in the Green Island area were subject to having excess water levels flood their basements, which included highly polluted water from the Blackstone Canal. This contaminated water was a serious health concern, and so the Blackstone Canal was buried to prevent it from seeping into homes and to cover up the stench that came from the canal's open air surface. Burying parts of the canal allowed the city to incorporate it into a new sewage system that was better able to provide sewage and runoff controls for the city. Over time, additional sections of the canal were buried and added to the sewer system, largely erasing any trace of its legacy.

2.1.1: Proposed Blackstone Canal Project

In order to revive the legacy of the buried canal while simultaneously stimulating the economy and creating an identity for Worcester, the Blackstone Canal Project was developed. Advocates of the project would like to develop a five-block-long reconstructed Blackstone Canal, creating a waterfront environment, in hopes of stimulating the economy and reviving the city's culture. In 2003, a feasibility study (Rizzo Associates, ICON Architecture, The Williams Group & Daniel R. Benoit and Associates, 2003) was conducted to assess the possibility of recreating the canal. According to the feasibility study, the eight main goals of this project are to:

1. Tell the Canal District's story
2. Maximize the Canal District's waterfront potential
3. Respect the area's historic fabric
4. Take full advantage of underutilized parcels of land
5. Designate three themed Gateways: Washington, Kelley, and Brosnihan Squares
6. Establish Kelley Square as a new front door to Worcester and the Canal District
7. Organize the plan around the Canal District's squares, unique settings, and water linkages
8. Create a pedestrian and bicycle network to and through the Canal District

Although project planners have indicated their intent to use green development techniques in the project, they have yet to fully explore the potential of incorporating an ecological services approach. This new Blackstone Canal Project could conceivably provide services similar to those provided by the original canal, with additional considerations. The project would need to place additional controls on any waste water usage to prevent the water from becoming dangerous or odorous. Alternately, developers could use other cities as examples, and provide new services not yet realized by the Blackstone Canal. We must find a balance between economics and ecology that maximizes overall benefit while achieving the original goals of the Blackstone Canal project.

2.2: Ecological Economics

In order to assess the achievement of both economic and ecological goals, it is necessary to find a means of comparison. This can be provided by examining the differences between ecological economics and conventional economics. Ecological economics originated due to the increasing awareness of the importance of ecological services and the constraints they place on human development, and it closes the gap on differences between the two individual studies of ecology and economy. The basic goals of ecological economics can be defined as follows:

1. Ensuring ecologically sustainable human behavior
2. Equal distribution of resources between current and future generations of both humans and other species
3. Efficient allocation of resources, especially ecosystem goods and services

Currently, ecological economics is used frequently in policy decisions in order to ensure sustainable development.

2.2.1: Distinguishing Ecological Economics from Conventional Economics

Economists and ecologists are often in opposition when it comes to preservation of the environment. The primary goal of mainstream economic policy is economic growth, which Daly and Farley (2004) define as "an increase in throughput, which is the flow of natural resources from the environment, through the economy, and back to the environment as waste" (p. 6). Conventional economists generally believe that the environment is a subsystem of the economy; it is a source of raw materials though which goods and services are produced in economic markets, but the environment is not able to limit economic growth because of the assumption that technological progress will always be capable of counteracting the effects of limited resources. Ecologists have adopted an opposing viewpoint, believing instead that the economy is a subsystem of the environment and thus cannot exceed the finite resource limitations inherent within the

environmental system. As stated by Cleveland, Costanza, Hall, and Kaufmann (1984), "The degree to which technological change can offset declining resource quality as some basic natural resources are depleted and/or mismanaged is an empirical question and cannot be easily predicted" (p. 891). Overall, economists are advocates of the perpetual growth of capitalism, whereas ecologists oppose this stance, believing that the economy will eventually exceed the capacities of the environment and lead to its continual deterioration. Realizing that each discipline is important for posterity, and that neither of them is mutually exclusive, a hybrid concept called "ecological economics" was born. The foundation of ecological economics is to "provide a framework for the equitable distribution of resources and property rights within the present generation of humans, between current and future generations, and between humans and other species" ("Costing the Earth," 1998, p.426).

2.2.2 From Land and Labor to Energy

Environmental contributions to economics have been regarded much more frequently in recent years. In the dawn of the twentieth century, as humanity continued to grow exponentially, limitations on the supply of natural resources started to be realized and people began to emerge from their classical ignorance. People came to understand that all economic wealth originates from natural resources and the services that nature provides. Chemist Frederick Soddy (1922) was quoted as saying,

> "Life derives the whole of its physical energy or power not from anything self-contained in living matter, and still less from an external deity, but solely from the inanimate world. It is dependent for all the necessities of its physical continuance upon the principles of the steam engine. The principles and ethics of all human conventions must not run counter to those of thermodynamics." (p. 9)

Soddy realized the importance of the "inanimate world" and its corresponding natural resources in our economy. Along with Soddy, a group known as the Technocrats also saw how vital a role the natural world played in the economic game, and formed the Technical Alliance in 1918. This alliance believed that economies should not use arbitrary monetary units as their benchmark, but rather units of energy. All goods and

services require the use of natural energy to exist, and they believed that presenting goods and services in terms of natural energy units would help raise awareness of their true costs and aid in the conservation of the natural world. In addition to changing the basic economic unit, the Technical Alliance wanted to replace traditional politicians with engineers and scientists, who would be better equipped to balance the needs of the economy and the environment (Cleveland, 1987, p. 54). A man named Howard T. Odum shared the beliefs of the Technocrats in that natural energy was the primary source of economic value, and that whenever a monetary unit, such as the dollar, flowed in one direction, equivalent energy units flowed in the opposite direction (Cleveland, 1987, p. 58-59).

In the 1950s, concern was growing amongst scientists with regard to the state of the natural environment. One man, W. Fred Cotrell, came to the conclusion that the American Industrial Revolution had more to do with the availability of natural resources than with the advancement of human knowledge. Cleveland (1987) stated that according to Cotrell, "The Industrial Revolution was revolutionary in economic terms because human labor was supplemented by enormous quantities of inanimate energy in the form of fossil fuels" (p.55). Cotrell believed that the availability of resources controlled the advancement of the economy and that economic growth would be bounded by these limits in resource availability (Cleveland, 1987, p. 55-56). Kenneth Boulding (1966) later documented this concern in "The Economics of the Coming Spaceship Earth." He created a foundation for modern ecological economics theories by describing the evolution of economic thought, from a state where growth was fueled by material consumption to a state where material availability was the constraint. This shift in vision illuminated the problems with resource allocation, creating an opportunity for ecological economics to emerge.

While concern continued to grow among professionals, Robert Costanza sought to validate Howard Odum's theory. Costanza conducted a study in which he found that there was a strong correlation between energy flow and monetary value. Through his study, Costanza (1981) created the "embodied energy theory of economic value" which

states, “The value of any good or service to humans is ultimately related to the quantity of energy directly and indirectly used in its production.” A geologist by the name of Earl Cook was concerned that the uninhibited preoccupation with pure economic growth would lead people to disregard the limits that exist in the supplies of natural resources. Cook believed that there were two possible courses of action to address the issue of limited and diminishing resources: (1) society could pretend that technological advancement and growth in human capital could replace losses in production caused by resource limitations or (2) lifestyles and mindsets could change in such a way that people realize the limits to growth and live within these boundaries. An important observation was made by Bruce Hannon (1977) of the Energy Research Group at the University of Illinois:

> “The absence of this awareness (of diminishing resources) is the root of the problem...The ignorance of the fact that there is a finite quantity of energy available is perhaps the greatest tragedy of this age.” (p. 99)

The majority of the world’s inhabitants are unaware of the urgency for conservation that is necessary to avoid significantly altering standards of living. Herman E. Daly (1985) made an important point when he commented that nature was not only our primary source of economic wealth, but also a ‘trash can’ in which we deposit all of our wastes (p.2). The growing concern with the state of the natural environment made the differences between economics and ecology clear, and established the need for an integrated approach.

2.2.3: Contemporary Ecological Economics Approaches

The contemporary viewpoint shared by most ecological economists revolves around adopting a policy that allows the environment to replenish its natural resources and economic growth to depend on further ‘economic development’ instead of allowing irresponsible exponential economic growth to continue. Daly and Farley (2004) define economic development as “the increase in quality of goods and services, as defined by their ability to increase human well-being, provided by a given throughput” (p. 6).

Through this approach, we can sustain a productive economic system while promoting a cleaner, healthier environment that can sustain itself for future generations.

While the views of ecological economists are promising in theory, they become unrealistic if people are not aware of their potential. Without a channel for educating people on the importance of environmental conservation in both economic systems and human survival, we are left with no defense against the inevitable outcomes of unrestrained exponential growth. To shed light on these issues, Daly and Farley (2004) provide three methods of looking at the environmental influence on economics: (p. 50)

1. Economic Imperialism
2. Ecological Reductionism
3. Steady-State Subsystem

The first approach, economic imperialism, is often used to bestow greater wisdom upon policy decisions. This strategy involves assigning all ecological goods and services a monetary value. The strength of this method is derived from its ability to consider human needs and wants, while emphasizing consumer preferences through the laws of economics. Giving the ecological goods and services a monetary value allows us to make direct comparisons between the costs and benefits of economic and ecological options. This method, however, provides little insight beyond pure monetary outcomes (Daly & Farley, 2004, p. 50-53).

Robert Costanza used the economic imperialism philosophy in his attempt to value all of the Earth's ecosystems. Costanza's goal was to increase people's awareness of the true value of the environment in their lives. In his study, he specifically named seventeen different ecological services, including:

1. Gas regulation
2. Climate regulation
3. Disturbance regulation
4. Water regulation
5. Water supply
6. Erosion control and sediment retention
7. Soil formation

8. Nutrient cycling
9. Waste treatment
10. Pollination
11. Biological control
12. Refugia
13. Food production
14. Raw materials
15. Genetic resources
16. Recreation
17. Culture

The aggregate value of all of these services was $33 trillion, which was larger than the world's combined GDP at the time (Costanza et al., 1997, p.254)

Costanza's study brought with it a large amount of controversy. Attributing an economic value to each ecological good and service requires complex calculations, which caused many to cast doubt on Costanza's results because he assigned similar ecosystems equivalent values without investigating valuation differences between them. As described by Bockstael, Freeman, Kopp, Portney, and Smith (2000), "Compensation measures cannot be defined in isolation. They are entirely dependent on the context and may change as there is a change in one of more elements of that context" (p. 1385). They realized that applying local measures of value to a global scale can lead to many inconsistencies due to variations in 'the context' of localities. Additional doubt came from others who labeled his $33 trillion figure as "a serious underestimate of infinity," ("Audacious Bid", 1998) implying that natural resources are fundamental to human existence, and that they cannot be replaced by a monetary value. Bockstael et al. (2000) point out that assigned monetary values must follow the laws of economics, which are based on tradeoffs. While Costanza's valuation of ecological services was $33 trillion, the world's GDP was only $18 trillion, and the offer to pay more than the world's income to preserve ecological services is completely infeasible. Through all of this controversy, however, one outcome remains: Costanza was successful in forcing people to consider the condition and value of the environment, something which is all too often is not given its proper weight in policy decisions (Costanza et al., 1997).

Daly and Farley's second approach, ecological reductionism, follows the idea that "Humans are not exempt from the laws of nature. ...Taken to the extreme, in this view of energy flows, embodied energy costs, and relative prices in markets are all explained by a mechanistic system that has no room for purpose or will" (Daly & Farley, 2004, p. 53). Ecological reductionism isn't used to shape policy decisions because if nature has predetermined how systems will function, changes in policy will have no effect.

The third and final approach is the "steady-state subsystem" approach, which is the most realistic with regards to real-world applications. Daly and Farley (2004) define this approach as "affirming the fundamental necessity of the boundary [between the ecosystem and its economic subsystem] and the importance of drawing it in the right place" (p. 54). The "steady-state subsystem" methodology focuses on allocating resources where appropriate, with respect to their individual characteristics, while remaining within the boundary between economic and uneconomic. When consuming resources is more costly than beneficial, you have achieved uneconomic growth, and choosing to preserve the natural resource instead of exploiting it provides for the greater net benefit.

Overall, the core concepts of ecological economics include recognition of the value of ecological goods and services and determining what levels of utilization allow for the greatest economic growth while maintaining a sustainable natural resource for future generations. As the human population, and its entire system, continues to grow, our dependence on natural resources rises accordingly and the concept of ecological economics becomes increasingly important for enabling a sustainable humanity. We face three choices in dealing with the effects of our own growth: (1) we can restore and preserve our ecosystems, (2) we can attempt to replace them with technology, or (3) we can ignore them and pass on the responsibility to future generations. In this project, we use the concepts of ecological economics, particularly the methods of economic valuation and the steady-state subsystem, to evaluate the possibility of utilizing a reconstructed Blackstone Canal to restore lost ecological services to Worcester, thus providing the city with economic gains through the ideas of ecological economics. We use an economic

valuation approach because it emphasizes consumer preferences while simultaneously valuing the environment, but we also want to use the steady-state subsystem approach to evaluate economic versus uneconomic growth. This combined approach allows for consideration of the condition of Worcester and its ecological and economic needs, and will hopefully make this condition known to citizens and policymakers.

2.3: Green Development/Infrastructure

Traditionally, many infrastructure projects such as roads and buildings have been built without much consideration for the environment. However, growing populations, as well as increasing dependence on natural ecosystems, have forced developers to consider different methods of infrastructure expansion in order to protect ecosystems and their services for future generations. It is known that ecosystems are disappearing at a rapid rate, and "ecological processes cannot function if natural connections are severed" (Benedict & McMahon, 2002, p. 16). In order to counteract the impacts of growth on ecosystems, the concept of "green infrastructure" was formed.

Green infrastructure is defined by Benedict and McMahon (2002) as "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations" (p. 12). A key factor in the development of the concept was that "ecologists have long recognized that the best way to preserve biological diversity and ecological processes is to create an integrated conservation system to counter habitat fragmentation" (Benedict & McMahon, 2002, p. 13).

Throughout history, infrastructure has been constructed in order to accommodate people and their desire for economic growth. More recently, however, people have been moving away from rural areas and urbanizing land at a faster rate than the population has been growing. For example, in the United States, the change in population from 1982-1997 was 6.91%, while the change in urbanized land was 39.10% (Benedict &

McMahon, 2002, p. 14). Green infrastructure takes problems like this into consideration, with its main purpose being to contribute to sustainable development.

While the aims of traditional development (economic stimulation) and green development (ecological services) seem to contradict each other, green development can be economically effective when well-planned. Poorly planned infrastructure can lead to the loss of natural areas, natural services, and water resources, while simultaneously increasing public costs and taxes. On the contrary, utilizing green development not only assists the environment, but can increase property values and decrease costs of public infrastructure. One example of this took place in Arnold, Missouri, where citizens have used greenways to replace flood-threatened regions, thereby considerably reducing the need for flood relief (Benedict & McMahon, 2002, p. 14-15). In order to reach the full potential of green development, however, developers need to make the incorporation of the environment a priority. According to Benedict and McMahon (2002), green infrastructure should be planned and laid out purposefully from its inception, funded in advance, and publicly supported (p. 15). When green infrastructure is successfully incorporated into land-use, it creates a balance between ecological and economic goals, and provides a means of conservation for the future.

One aspect of the environment that can be greatly affected by green development is water use. According to Daly and Farley (2004), "Global water consumption has tripled over the last 50 years, and it continues to climb. Humans are pumping rivers dry and mining water from aquifers faster than it can be replenished" (p. 116). Studies have suggested that by 2025, a majority of the world's population will live in regions with water shortages (Daly & Farley, 2004, p. 117). Fortune magazine stated that, "Water shortages will make water the oil of the twenty-first century, 'the precious commodity that determines the wealth of nations'" (Currier, 2003). In areas where water is an available, abundant resource, it is being consumed at much too fast a rate. According to the Rocky Mountain Institute (2006),

> "Most governments, utilities, and water users are making the same mistakes with water that they have made with energy: depleting

> nonrenewable supplies, using the highest-quality water for every task, supplying more instead of making more productive use of what they have, building big water infrastructure systems without considering what the best size is for the job, and failing to protect and take advantage of the services ecosystems provide."

Historically, the approaches many municipalities have taken with respect to water use can be harmful to the environment, creating an ideal opportunity for green development.

Overall, communities need to make wise decisions concerning conservation in order to maintain a trend of sustainable development. According to Benedict and McMahon (2002), "Just as these communities need to upgrade and expand their gray infrastructure, they need plans to upgrade and expand their green infrastructure" (p. 17). Green development is not nearly a fad; it is "smart conservation for the twenty-first century" (Benedict & McMahon, 2002, p. 17). Integrating ecological services into urban infrastructure planning represents a sensible approach which not only provides services to citizens, but can also reduce the amount of resource consumption in the surrounding area. Using the concepts of ecological economics, these services can be valued and incorporated into the economic goals of cities. Also, given the high population density of cities, this can be the critical factor in economic urban growth.

2.4: Ecological Amenities

Recreational and cultural opportunities are included in many ecological economists' definitions of ecosystem services. However, these services differ from other ecological services. While humans benefit from recreation and culture, they're not entirely dependent on them, and these opportunities can be found in many alternate settings. For this reason, we refer to recreation and culture provided by the natural environment as "ecological amenities".

An increasing population in the United States, combined with a declining density, has forced citizens to develop over large portions of the natural environment, largely reducing these ecological amenities. As of 2003, it is estimated that an area the size of

Georgia has been paved over in the United States (Jackson, 2003, p.1382). Considering this fact, while keeping other types of infrastructure in mind, it is clear that the United States has become widely developed. Balling and Falk (1982) suggested that this widespread development has produced significant negative effects on the aesthetic environment, enough so that political officials have been forced to take a critical look at land-use policy (p.6).

One of the main challenges faced by the current generation is to incorporate ecological amenities into future design plans, especially since studies have shown that the physical environment can affect human health (Jackson, 2003, p.1383). As Jackson (2003) states, "it is time for a shift to communities intentionally designed to facilitate physical and mental well-being" (p.1383). Some environments encourage physical activity and social interaction more than others, so the first step is to determine which environments promote well-being the most. Many studies have been done concerning environmental effects on human behavior and health. For example, Zube (1974) concluded that humans particularly enjoyed natural scenes that included water, and Kaplan (1977) allowed residents to view photographs of storm drains in different settings, and advised county officials to place drains in a natural setting so as to appease public preference obtained through the study. These studies allow city officials and developers to acquire an understanding of ideal public settings according to nearby residents, and can be incorporated into future development projects in order to reach full economic and ecological potential.

3: Methodology

The goal of this project was to determine how a reconstructed Blackstone Canal can provide environmental services for the citizens of Worcester while simultaneously fulfilling its main goal of economic stimulation. This was accomplished by identifying links between urban infrastructure and ecological amenities, providing examples of these amenities, and explaining how certain amenities can be easily incorporated into the Blackstone Canal Project according to the needs of Worcester's citizens. Initially, ecological amenities projects were researched according to certain criteria. In the process, two additional projects were discovered which did not completely adhere to the standards of an ecological amenities project. Therefore, they were classified into two additional categories: ecological economics and green infrastructure. The distinction between types of projects and an explanation of the selection process follows.

3.1: Types of Projects

As previously stated, three types of projects were researched and analyzed: ecological amenities projects, ecological economics projects and green infrastructure projects. Each type has its own strengths and weaknesses in terms of its applicability to Worcester.

Ecological amenities projects are those in which the main service provided is recreational or cultural. They are not intended to provide ecological services to local residents, but rather to appease their desire for a beautiful environment. This report focused on those projects that were centered on an urban waterfront, because their results are more similar to Worcester and the Blackstone Canal Project. Through researching these projects, it was possible to demonstrate the attraction to waterfronts, and how they affected the local economy and/or ecology. Many cities have completed this type of development, a few of which are: San Antonio, Chicago, Providence, Portland (Oregon), Chattanooga, and Charleston (South Carolina). These cities, along with others, are

mentioned often in urban waterfront redevelopment literature. Some examples of this literature are:

1. Remaking the Urban Waterfront (2004) by Fisher, Gordon, Holst, Krieger, McMillan, and Rafferty.
2. Ecological Riverfront Design: Restoring Rivers, Connecting Communities (2004) by Otto, McCormick, and Leccese.
3. Waterfronts in Post-Industrial Cities (2001) by Marshall.

These books were found by searching the keywords "urban waterfront redevelopment" on both Google Scholar and Worcester Polytechnic Institute's library search engine. Otto, McCormick, and Leccese's book also provided online sources for each individual project it discussed. The projects discussed in that book then became the basis for the projects that were researched. Searching for "urban waterfront redevelopment" on the internet also provided alternative electronic sources. These sources were reviewed, and a list of 22 ecological amenities projects was compiled.

Ecological economics projects are those which have identified both ecological and economic goals. These projects were researched to explore the feasibility of accomplishing both types of goals simultaneously. An interesting aspect of these projects is that they consider how ecological and economic goals can influence each other in positive and negative ways.

The third type of project examined was green infrastructure projects. These projects exemplify how city planners sometimes do not need to restore ecosystems; ecological services can be incorporated directly into the urban infrastructure. Due to the increasing awareness of humankind's dependence on ecological services, green or "smart" development is discussed often.

3.2: Case Study Selection

As previously stated, ecological amenities projects were discovered using many different avenues. The 22 ecological amenities projects compiled were first researched

according to 6 criteria, which all hold importance when comparing their results to the potential of the Blackstone Canal Project. The criteria were:

1. City location
2. City population
3. Type of waterway
4. Original purpose
5. Current use (project goal)
6. Year of redevelopment

The first criteria listed were basic facts about the city in which the project was completed. City location is an important criterion because there are many differences in climate between different regions of the United States (and the world). Given that the main goal of this project is to explore potential ecological services, it helps to realize that climate can affect the type of ecological services and also the degree to which it can be effective. Thus, those projects which were done in the northeast, or a similar climate, were more applicable to Worcester's project. Secondly, the city population gives an idea of how many residents were affected by the project. If a project was done in a city significantly larger than Worcester, it was most likely on a larger scale in order to accommodate more residents, but this would most likely come at a larger cost. The opposite is true with a smaller city. In order to eliminate this bias, we attempted to choose projects with a population close to Worcester's, using population data from the year 2000 obtained through the U.S. Census website (http://quickfacts.census.gov/qfd/). Finally, the type of waterway was examined. This was researched because it is important to understand the city's ties to the waterfront, and possibly its dependence on it. If the waterway is a river running through the heart of the city, as in Portland, Oregon, residents are going to have a different connection to it than if it were a harbor located on the outskirts. In terms of applicability to the Blackstone Canal Project, a waterfront in a centralized location would be ideal because the proposed Blackstone Canal would be located in downtown Worcester.

Next, information was obtained about the project itself. The original purpose of the waterfront gives a basis from which to start, and the current use demonstrates the goals of the project. Combining these two criteria demonstrates the transition from an

area ineffective in some aspect to one which accommodates the needs of nearby residents. Those projects which were converted from industrial purposes in the past to current ecological and economic purposes are most similar to Worcester. Finally, the year of redevelopment is important to know because technology and societal needs change rapidly, and therefore, projects done recently are more likely to be used as a model. Based on the six criteria, two of the most suitable ecological amenities projects were then selected to be researched more in depth (Chattanooga, Tennessee and Portland, Oregon).

While researching ecological amenities projects, information on the "northern water feature," which was part of Sydney's Olympic redevelopment plan, was found in Remaking the Urban Waterfront (2004) by Fisher et al. This project was then researched according to the criteria for ecological amenities projects; however, it did not fit the definition of an ecological amenity project. This was because the project was designed to incorporate ecological services into the infrastructure, and the entire project was not based on the waterfront. For this reason, it was designated as a green development project. Although it didn't adhere to the other projects being researched, it provided many attractive properties. For example, it was completed recently, it provided economic stimulation, and it made ecological services a priority by creating water features that aerated and cleansed water. In addition, the redevelopment plan included building energy efficient infrastructure.

Finally, while researching ecological economics for the background, New York City's restoration of the Catskills continued to reappear. Consequently, it was researched according to ecological amenities projects, but it also did not fit with ecological amenities projects. This was because it was completed outside the city, and its main purpose was to provide ecological services at the lowest cost. For these reasons, it was considered a suitable ecological economics case. It was completed recently, avoided alternative costs (for an engineered filtration plant), and was centered on the provision of high quality water for a drinking water source.

3.3: Case Study Analysis

For each selected project, five aspects of the project's planning and development were examined more in-depth. These included:

1. Economic goals
2. Ecological goals
3. Funding
4. Public involvement
5. Results (ecological and economic effects)

The main purpose of most redevelopment projects, like the Blackstone Canal project, is to create economic stimulation. The selected projects have also incorporated ecological goals into their plans. Being aware of the original economic and environmental state of the region and its plans for improvement creates a basis from which to compare these improvements, thus making it easier to determine the potential of the Blackstone Canal Project.

Specifically, it is important to know the plan's economic and ecological goals. Three key questions with regard to economic goals are:

1. Was money earned, and if so, how much?
2. Were costs for environmental improvements avoided elsewhere?
3. How did developers plan on achieving their goals?

These questions addressed the possibility of a project being economically successful while still achieving ecological goals. Thus, it is then important to know the ecological goals of the project; in particular, the intended ecosystem services to be provided. Understanding the background of a region and its need for certain economic and ecological goals creates a benchmark to compare results against later.

In order to relate projects to the Blackstone Canal project, it was important to research the funding of these projects and their level of public involvement and support. Funding sources used in these projects could provide examples of organizations that

would also fund ecological improvements through use of the Blackstone Canal. Also, many public projects can be funded using taxpayers' money. Therefore, it is important for city officials and developers to understand the level of public support or opposition to a project. If Worcester's city officials could find a similar support base for ecological improvements, it could not only make the need for ecosystem services better known, but also supply a source of funding.

3.4: Application to the Blackstone Canal Project

The final analysis of this report uses the information provided from the case studies to provide recommendations to Worcester's city officials regarding the Blackstone Canal Project. Four issues relating to feasibility were examined: (1) the integration of economic and ecological goals, (2) funding, (3) public involvement, and (4) outcomes. In some cases, ecological and economic goals were difficult to attain simultaneously due to the levels of priority given to each. The four case studies (Chattanooga, Portland, New York City, and Sydney) helped provide guidelines as to how Worcester would need to prioritize its goals in order to be successful. Also, if Worcester is unable to obtain additional funding to adequately achieve and maintain ecological goals, it would be unrealistic to try. The case studies provided examples of potential funding sources, and these sources were examined to determine if the same type of funding would be available to Worcester. Next, public involvement was explored. Public involvement generally leads to public support which could create additional funding and a greater stimulated economy, thus creating a more successful project. If Worcester could adopt a plan that involves the public similar to a successful completed project, it could be more successful. Finally, the outcomes of each completed project were examined to determine if Worcester could achieve the same level of results. Upon completion of evaluating each issue, conclusions were drawn and recommendations were given regarding the potential of the Blackstone Canal Project.

4: Results

The goal of this project was to determine the potential of the Blackstone Canal Project in Worcester by looking at previous projects that have incorporated ecological goals into economically-driven projects. Initially, 22 ecological amenities projects were researched, and in the process, an ecological economics project and a green infrastructure project were discovered. The 22 ecological amenities projects were then narrowed down to two according to certain criteria in order to find those most applicable to Worcester. The four final case studies were then researched further according to ecological and economic goals, funding, public involvement, and results. The characteristics of each case were then examined in terms of their applicability to the Blackstone Canal Project in Worcester, and recommendations were made regarding the canal redevelopment.

4.1: Initial Case Studies

Characteristics of a total of 24 projects, including ecological amenities, ecological economics, and green infrastructure, were compiled to be researched further. These projects are presented in Appendix I. Information given in this appendix includes:

1. City Name
2. Type of Project
3. City Location
4. City Population
5. Type of Waterway
6. Name of Waterway
7. Original Purpose
8. Current Use
9. Year of Redevelopment
10. Funding Sources
11. Other Relevant Information

Certain information, such as the city name and name of waterway, was collected primarily for reference purposes. Other data were collected in order to choose certain cases to research further, as described in Section 3.2. The last column, "Other Relevant

Information," allowed inclusion of information that did not fit in another category, but was either interesting or applicable to Worcester's Blackstone Canal Project.

Twenty-two ecological amenities projects were identified. The projects spanned 13 states, with 9 in the Northeast, 3 in the Southeast, 2 in the Midwest, 5 in the Southwest, and 3 in the Northwest. All of the projects were waterfront redevelopment projects. Initially, the list of 22 projects was reduced based on the current use of the waterfront. Those not concerned with ecology and the environment were eliminated. The projects eliminated in this stage included: Baltimore, Boston, Charleston, Greenwich, Hartford, New York (2), Providence, Salem, San Diego, St. Louis, Stamford, Suisun City, and Tacoma. Next, the original purpose of the waterfront region was examined. Those whose purpose was not industrial were eliminated, including: Napa, Redmond, and San Jose. Finally, city population was examined. Those with populations over 600,000 were deemed less applicable to Worcester, and therefore eliminated, including: Chicago, Detroit, and Los Angeles. This left two ecological amenities projects to examine: Portland, Oregon, and Chattanooga, Tennessee.

After the ecological amenities projects were selected, one ecological economics project and one green development project were also considered and researched further. This resulted in a total of four projects chosen from this compilation: Chattanooga, Tennessee's waterfront redevelopment along the Tennessee River; Portland, Oregon's waterfront redevelopment along the Willamette River; New York City's restoration of the Catskill Mountains (ecological economics); and Sydney, Australia's 2000 Olympic bid (green development).

4.1.1: Chattanooga, Tennessee

Chattanooga, Tennessee, a city with a population of approximately 150,000, had been a city lacking any real identity. In addition to social and racial tensions, the city had been experiencing large amounts of industrial growth after the Industrial Revolution. This growth degraded the health of the Tennessee River, which runs directly through

downtown. There was legal and illegal dumping of wastes, polluted groundwater, and a large amount of construction and channelization being done to the river.

In 1969, the damage being done to the environment in Chattanooga peaked and the U.S. EPA named Chattanooga the "dirtiest city in America" (Otto et al., 2004, p. 109). Around this time, the air pollution from industries created smog so dense that motorists had to drive with their lights on during the day ("The Chattanooga Riverpark," 1998). Due to an industrial decline in the city, businesses relocated and the areas near the riverfront became eyesores. As it is described in "21st Century,"

> "On the heels of back-to-back recessions, downtown Chattanooga had suffered the exodus of its major retailers, leaving a handful of hearty merchants who made their living off the working population. There was very little happening after 5 p.m."

In response to the decline of the city, residents developed the Chattanooga Venture in 1984. The Chattanooga Venture was a non-profit organization which provided citizens the opportunity to participate in the city's future ("Best Practice," 2006). After participants voiced their concerns and shared personal visions for the city, the organization devised their first plan: Vision 2000. This plan was aimed at increasing tourism and rejuvenating the economy through multiple programs, including environmental programs.

4.1.2: Portland, Oregon

Portland, Oregon, home to the fourth-largest port on the west coast, lies on either side of the Willamette River (see Figure 1). The river, originally called Willampth, or "green water," by its first dependents, has long been a source of food, water, and transportation for nearby residents. It holds such a strong connection to the city that sometimes residents refer to Portland as River City (Otto et al., 2004, p. 134).

Figure 1: Willamette River, Portland, Oregon
(Source: "Willamette River and Portland, Oregon," 1988)

Portland has always been a city known for its environmental awareness. It currently contains more than 200 parks, an urban wildlife refuge, bicycle and pedestrian trails, and numerous boat launches, and has successfully integrated the environment into the urban setting. As Ehrenhalt (1997) stated,

> "Every week out of the year, somebody arrives in Portland, Oregon, from far away, wanting to know the secrets of big-city livability. And invariably they fall in love and return home proclaiming that they have seen a glimpse of urban life as it ought to be lived in the century to come."

Unfortunately, Portland's environmental awareness has not always resulted in a clean, healthy river.

The Willamette River has been degraded and restored numerous times. Mayor Vera Katz (2001) described it well, "The story of the Willamette reads like a potboiler romance – one of love, abuse, neglect, partial redemption, and unrequited promises." In the early 1900's, raw sewage was regularly being discharged into the river, and in 1911, the Oregon Board of Health declared the Willamette "an open sewer" (Otto et al., 2004, p. 134). However, little action was taken until 1962, when Tom McCall documented the

state of the river. Later on, when McCall became governor, he led the effort to clean the river.

In the 1970's, the first steps were taken to incorporate the river into the cityscape. First, Harbor Drive, a freeway which ran parallel to the river, was demolished and replaced by a public park, later named Tom McCall Waterfront Park, in an attempt to reconnect people to the riverfront. Next, Portland developed its first urban wildlife refuge. It was officially protected from development and named Oaks Bottom Wildlife Refuge in 1988. Finally, officials developed the City Greenway plan in 1979. The goals of this plan were to restore the river, increase public access, and conserve surrounding natural habitats.

Although the effort had begun, it became clear in the fall of 2000 that additional action needed to be taken. As Katz (2001) said,

> "It's time to look our history straight in the eye and admit the sad truth: a disfigured and sickly river still runs through Portland. We have dammed it and diked it, filled it and diverted it, choked off its tributaries, and paved over much of its watershed, floodplains, and habitat. We've used it as a ditch, as a dumping ground, and a sewer and waste conveyor."

As of 2002, 994 bodies of water in the area were declared water quality impaired, including the entire Willamette (Oregon Department of Environmental Quality, 2003). Due to the ever-declining state of the Willamette River, city officials enacted the River Renaissance plan, which was designed to achieve a number of ecological and economic goals.

4.1.3: New York, New York

In 1989, due to concerns about microbial contamination, the U.S. Environmental Protection Agency (EPA) created the Surface Water Treatment Rule, which mandated that all surface waters used as community drinking water sources must be filtered and disinfected. In particular, the rule stated that all water supply systems must provide a combined 99.9% removal and/or inactivation of *Giardia*, a 99.99% removal and/or

inactivation of viruses, and a disinfectant must be continuously present in the distribution system ("Drinking Water Standards," 2006). The requirement for filtration could be waived, however, if existing or natural processes provided clean water according to certain declared standards (Perrot-Maitre & Davis, 2001, p.25). For example, a municipality with a waiver was required to create a watershed protection program, ensure that the water supply was free of waterborne diseases, and undergo annual on-site inspections ("Surface Water," 2007).

The city of New York provides approximately 1.34 billion gallons of safe drinking water every day to its 9 million residents ("Protecting New York," 2002). Ninety percent of the drinking water originates in the Catskill and Delaware watersheds, located 125 miles north of the city. These watersheds lie in rural areas of the Catskill Mountains, contain a total population of 77,000 and cover a total area of approximately 1600 square miles (Perrot-Maitre & Davis, 2001). The other ten percent of New York City's water supply is provided by the Croton watershed, located fifty miles away, just north of Long Island Sound. The water supply system is shown in Figure 2.

Figure 2: New York City's Water Supply System
(Source: "New York City's Water Supply System)

In response to the EPA regulations, city officials decided to build a filtration plant to treat water from the Croton watershed due to high levels of phosphorous and organic compounds (Principe, Stasiuk, & Stern, 2000). However, water from the Catskill and Delaware watersheds was higher quality. Thus, city officials examined two options: construction of a filtration plant or restoration of the Catskill Mountains area in order to rejuvenate natural filtering processes. Up until 1990, development within the watersheds had increased erosion and runoff along the majority of its streams. Through the study, it was determined that constructing a filtration plant would require $6-8 billion in capital expenditures with an additional $300-500 million per year in operating costs. In contrast, a watershed protection program would cost $1-1.5 billion over ten years (Perrot-Maitre & Davis, 2001). Considering a ten year time period, the total cost of a filtration plant would be $9-13 billion, while the watershed protection program would be $1-1.5 billion. Due to the cost-effective nature of the watershed program, the city decided to restore the Catskill Mountains instead of building a filtration plant.

4.1.4: Sydney, Australia

In the 1990s, when green development principles began gaining momentum as a global issue, the International Olympic Committee (IOC) became intent on holding a "green Olympics" in 2000. The IOC wanted to make environmental considerations part of the criteria for selecting a host city for the games. In the bid books, which explain the criteria used for selection, there was an entire chapter on environmental considerations.

Sydney, Australia, recognized the stress the IOC placed on the environment's importance and developed the Sydney Olympic Bid Limited (SOBL). This committee was responsible for Sydney's Olympic bid, and their main goal was to "make Sydney's Olympic plan a prime example of ecologically sustainable development in the 21st century" (Lessons, 2000, p. 26). The two things the SOBL planned to do in order to achieve this goal were to (1) remediate Homebush Bay, a former industrial dumping

ground, and (2) utilize development methods and construct facilities in a way that would minimize environmental demands.

In order to ensure these objectives, the committee also developed guidelines for the site's development, based on Ecologically Sustainable Development (ESD) principles. "Championing the Environment" (2003) names five ESD principles, including:

1. Integrating economic and environmental goals in policies
2. Ensuring environmental assets are properly valued
3. Equity between current and future generations
4. Recognizing risk and irreversibility
5. Recognizing the global dimension (p. 3)

Each of these concepts was taken into consideration throughout the entire project, from development and construction stages through the time when the site was to actually hold the Olympic Games. While all stages of planning appeared sound, Beder (1993) stated, "Sydney's biggest problem was that the city's proposed site was to be amidst one of Australia's worst toxic waste dumps" (p. 1). However, this setback was counteracted by Sydney's apparent environmental concern, and the city's Olympic bid was selected over Beijing, Berlin, Istanbul, Manchester, and Milan.

4.2: Case Study Analysis

The selected case studies (Chattanooga, Portland, New York, and Sydney) each used different approaches in order to attain their specific goals. The following sections describe each city's economic and ecological goals, their methods of funding and level of public involvement, and the outcome of the project. This information is evaluated in terms of its applicability to Worcester and the Blackstone Canal Project.

4.2.1: Ecological and Economic Goals

Each case study contains its own ecological and economic goals according to its specific needs. Chattanooga's plan, Vision 2000, included a number of economically

driven programs in order to increase tourism and bring businesses back to rejuvenate the city's economy. Chattanooga Venture developed programs such as the Chattanooga Neighborhood Enterprise, the Orange Grove Materials Recovery Facility, and Jobs 2000. The Chattanooga Neighborhood Enterprise was created to develop, finance, and manage low-income housing for citizens in the area. The Orange Grove Materials Recovery Facility's main purpose was to employ mentally challenged adults in a recycling center. As a result of this project, Chattanooga handles recyclables at a much lower cost than similarly sized cities. The Jobs 2000 program researched area businesses to determine their needs in terms of employees. Overall, Vision 2000 consisted of over 200 projects and programs. These programs created 1,381 permanent jobs and 7,300 temporary construction jobs. The total cost of the project was $793 million and served over 1.5 million ("Best Practice," 2006). Chattanooga's revived waterfront is shown in Figure 3.

Figure 3: Tennessee River, Chattanooga, Tennessee 2003
(Source: Anderschwan, "Tennessee River, 2003)

A number of ecologically-driven programs were also created as part of Vision 2000. First, the Environmental City project was concerned with the expansion of non-polluting businesses in the area and environmental awareness. Second, the Chattanooga Environmental Initiative focused on making Chattanooga the center of environmental

business. Next, the Tennessee River Gorge Trust was developed to protect 25,000 acres of ecologically rich land. Finally, the Greenways Planning Project created a network of open space throughout the region ("Chattanooga," 1996). Additionally, in order to draw attention to the waterfront, the participants of Chattanooga Venture developed the 21st Century Waterfront Trust. The purpose of this program was to develop a world-class waterfront, complete with open space, a public pier, and other environmental amenities for visitors to enjoy. The plans for this project were formed by Hargreaves Associates of Cambridge, Massachusetts, and were adopted unanimously by the city council in 2002 ("21st Century").

Of all the projects and programs included in the Vision 2000 plan, the key feature was the Tennessee Riverpark Master Plan, which was created in order to bring attention to a section of Chattanooga's riverfront. The main goal of this plan was to create $750 million of mixed-use development and environmental enhancement along 22 miles of the river's edge, from Moccasin Bend through downtown to the Chickamauga Dam ("Managing Greenways," 2000). This section of river is shown in Figure 4.

Figure 4: Tennessee Riverpark Section of Tennessee River
(Source: Google Earth, 2007)

River Valley Partners (originally River City Company) was used to design and construct the Riverpark, and it was to cover 10 miles on either side of the 22-mile shoreline ("The Chattanooga Riverpark," 1998). They developed picnic facilities, parks, playgrounds, and fishing and boating areas. One of the largest projects they undertook was the restoration of the 105-year-old Walnut Street Bridge. It is now a major tourist destination in Chattanooga as one of the largest pedestrians-only bridges (Otto et al., 2004, p. 108). The bridge is shown in Figure 5.

Figure 5: Walnut Street Bridge
(Source: Sengupta, "Walnut Street Bridge," 2007)

Portland's citizens, through the River Renaissance program, developed a number of ecological and economic goals similar to those in Chattanooga. According to Otto et al. (2004), the goals in Portland were to:

1. Clean and restore the Willamette River
2. Maintain or improve the economic condition of the harbor
3. Embrace the river as Portland's "front yard"
4. Create an energetic and inviting waterfront region

The key ecological goal of the program was to revitalize the Willamette River and restore its ecological services. In order to achieve this goal, a number of objectives were identified. First, buffers and tributaries along nearby creeks were improved in order to protect the quality of water which flowed into the Willamette. Secondly, it was important

to naturalize the banks. This would restore natural filtering processes for runoff which ended up in the river. It was observed that, "Fifty-one percent of the bank is armored with rocks and other riprap; 21% is covered by structures such as pilings, 26% is natural, and 2% is bioengineered" (Otto et al., 2004, p. 140). It was also proposed that the greenway setback (distance on each side of the river that must contain greenways) should be increased from 25 feet to 100 feet. Once the shores were softened, the next objective was to encourage residents to plant native vegetation to further increase natural filtering capabilities. After that, it was deemed necessary to eliminate, or at least drastically reduce, the number of combined sewer overflows (CSOs). Every year, 2.8 billion gallons of waste was entering the river. City officials made it a goal to reduce this amount by 94% by the year 2011 by redesigning city street and building designs. Finally, a Superfund cleanup was initiated. This cleanup included the efforts of the Port of Portland and 72 other parties, and was initiated to remove or isolate pollutants.

The next three goals of the River Renaissance in Portland pertained primarily to economics. They were designed in order to stimulate the economy while not harming ecological efforts. The first economic goal concerned the maintenance of the harbor. The plan was to adopt new technologies and industrial practices that would be able to coexist with or complement water quality restoration efforts. The urban infrastructure was also to be redesigned in order to better integrate into the natural environment recreated along the coast. The second and third goals, to embrace the river as Portland's front yard and create an inviting waterfront district, were identified in order to draw residents and tourists to the river. This would create opportunities for businesses to thrive within the area, thus stimulating the economy.

New York City, on the other hand, had less flexibility due to a more specific ecological need. It needed to provide water purification services at the lowest possible cost. Due to the previously discussed cost-saving potential, New York City created a watershed protection plan in September 1990, which identified the following goals:

> "The program will work to retain a working landscape that can provide forest products, economic return to rural communities and forest

> landowners, and open space for recreation and wildlife habitat, while providing a high level of protection for the water supply and sustaining forest cover." ("Protecting New York," 2002, p.2)

The main purpose of the watershed program was to restore and protect ecological services and amenities provided by the Catskill Mountains at the lowest possible cost. If successful, the program avoided the larger cost of a filtration plant while simultaneously improving New York City's water supply. Part of the program involved acquiring critical land near reservoirs and wetlands. Additionally, development rights were bought from residents by the city in order to prevent further growth in the watershed (Perrot-Maitre & Davis, 2001). It was estimated that upon completion of the project, 61% of land in the Catskill and Delaware watersheds would be privately owned, while 38% will have been purchased by city and state governments ("Protecting New York," 2002). The remaining 1% already belonged to the state or city.

Sydney, Australia, had a large number of both ecological and economic goals. First, in order to create the opportunity for economic development through the Olympic games, Sydney needed to rehabilitate the Homebush Bay area. This area was enclosed by "chemical industries, a fuel terminal, a large petroleum products storage area, an oil refinery, and a prison" (Beder, 1993, p.1). Excessive landfilling led to over 9 million cubic meters of waste, including chemicals, heavy metals, asbestos, and dioxins. According to "Lessons" (2000), "Greenpeace revealed that according to their findings dioxin contamination on the Olympic site itself had levels of toxic rating 1,500 times higher than the 'safe' United States' standard for residential areas" (p. 30). Technological restrictions in Australia left developers with two options. They either had to treat the contaminated soil or remove it in order to prevent exposure to humans. For cost and feasibility reasons, developers chose to have the contaminated soil moved from less-contaminated areas into more-contaminated areas of the Homebush Bay site in order to create additional room for development.

Once the area was rehabilitated, the Olympic Coordination Authority's environmental strategy was able to commence. Their plan consisted of three main components:

1. Conservation of species
2. Conservation of resources
3. Pollution control

Each component contributed to the environmental goals originally identified by the SOBL committee.

First, in order to protect the endangered Green and Golden Bell Frogs suffering from degraded wetlands, developers recreated wetlands along the edge of the site. In addition to the ecological services wetlands provide for humans, this also created a natural habitat in which the frogs could thrive.

Secondly, the OCA was concerned with the conservation of natural resources, especially water and power. In order to conserve water, planners developed a system that reused stormwater runoff. The wetlands collected and cleansed runoff, and then a water feature, named the Northern Water Feature, filtered, aerated, and reused the water throughout the park for drinking and irrigation. The water feature is shown in Figure 6. The SuperDome (see Figure 7), which held gymnastics and basketball events, also recycled water for irrigation purposes by collecting it on the roof.

Figure 6: Northern Water Feature
(Source: Gollings, "Northern Water Feature")

Figure 7: Sydney Olympic SuperDome
(Source: "Stadium Australia," 2001)

Additional water conservation measures were incorporated into the Olympic Village. The Olympic Village is a collection of 665 houses which housed Olympic athletes during the events in 2000 (see Figure 8). It used a specially designed dual-pipe system which cut water consumption by 50% by using recycled water for toilet flushing and gardening use. The SuperDome and Olympic Village also integrated power conservation measures.

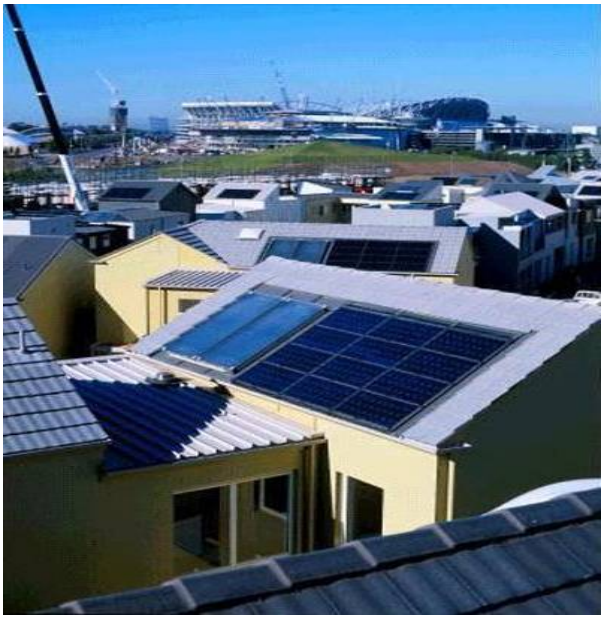

Figure 8: Sydney's Olympic Village
(Source: "Olympic Village, Sydney," 2003)

With its entire roof designed as a solar collector, the SuperDome runs on 100% green power. The Olympic Village also used solar power. At the time, it was the world's largest solar suburb. It also used passive development concepts, which include methods such as north-facing buildings, natural ventilation, larger windows, and the use of insulation materials. These measures also reduced power consumption in the Olympic Village by 50% compared to conventional homes.

Pollution control was also a priority of the Olympic Coordination Authority. Beginning in the construction stage, wastes were reused and recycled. Developers used mostly environmentally friendly materials and products, and 90% of construction wastes from the Olympic Village were recycled. Waste that was unsuitable for construction was recycled in the "millennium markers". There are 5 millennium markers, which are 10-20 meter high earth mounds. They were not only a means of waste disposal, but also created an architectural landscape. Throughout Olympic events, recycling bins were used to recover 77% of waste in eight color-coded waste streams. These bins collected many types of waste, including commingled containers, clean paper and cardboard, glass, medical waste, cooking oil, compostable waste, residual waste, and reusable waste. Additionally, the Olympic Village reduced greenhouse gas emissions in half compared to

traditional homes. During Olympic events, public transportation was provided and encouraged. Overall, Leece (2001) describes Sydney's efforts as "Inspiring architecture that successfully incorporated the built and natural environments" (p. 3).

These four case studies show how it is possible to integrate ecological and economic goals, regardless of the degree or type. Even if the project originated solely for economic reasons, it is possible to achieve ecological goals as long as they are made a priority. Sometimes, ecological achievements will assist with rejuvenating the economy.

4.2.2: Funding

In each case study, funding was acquired in a different way according to the particular needs of a project and resources available. Chattanooga, Tennessee's funding for the 21st Century Waterfront Trust was needed quickly due to the 36 month time frame provided by Mayor Bob Corker. Therefore, Mayor Corker spearheaded the effort, collecting funding from four main sources. First, a hotel/motel tax was instituted by the state, providing $56 million. Secondly, the Mayor ran a fundraising campaign by holding meetings with wealthy, influential citizens. These meetings provided a total of $35.6 million ("21st Century"). Additionally, the state and federal governments contributed $6.2 million, and land sales and parking supplied the city with another $4 million. Since the project was expected to cost approximately $120 million, this left the city with $18.2 million in debt.

In contrast, Portland's River Renaissance is a fairly recent project with a long time frame. Full funding for the project has not yet been determined, but city officials are hoping that with the abundant amount of time, funding will be easily secured. For this project, a combination of public and private funding will be used. Gil Kelley, director of the city's bureau of planning, believes in the power of short-term victories in achieving long-term goals. He began planning early, developing 10 early action steps estimated to cost around $5 million. According to his estimations, $2 million was expected to come from the city and the rest was to come from federal and private funds.

The New York City project was a large project, including land acquisitions and the rehabilitation of current water supply. Funding for these activities was obtained through three main avenues: taxation, bonds, and trust funds. First, the city taxed an additional 9% on water bills for five years, from 1990 until 1995. Next, they created NYC Bonds. Lastly, they used a number of trust funds. One fund used, The Catskill Fund for the Future, was a $60 million fund that provided loans for ecologically sustainable projects. Another fund was the NYC Trust Fund, which provided $240 million for projects in the Catskills, and $70 million for projects in the Delaware watersheds. Using these sources, the city covered initial costs for the program; state and federal governments provided supplementary funding.

Sydney obtained its funding from two main sources. The first was the Olympic Coordination Authority (OCA), which was created by the New South Wales (NSW) government in order to oversee construction of all venues and collaborate with the government. The OCA defined Sydney's initial budget at $2 billion, twenty-five percent of which was to be set aside for environmental objectives. Sydney's state government also provided support, allotting $30 million of the state budget for rehabilitation of the proposed site. The Sydney Organizing Committee for the Olympic Games (SOCOG), also created by the NSW government, provided additional funding. The SOCOG's main responsibilities included ticketing, licensing, ceremonies, and sponsoring. It raised over $2.83 billion, comprised of $1,132 million for broadcasting rights, $686 million in sponsorships, $73 million in licensing rights, $616 million in ticket sales, and $325 million from other sources (Pricewaterhouse Coopers, "Business and Economic Benefits").

There are many different funding sources used in these projects. Chattanooga used taxation and private donations from wealthy citizens. Portland is planning on using a mixture of private and public funds from both the state and federal branches. New York City used taxation, bonds, and trust funds. Finally, Sydney obtained most of its funding from the OCA and SOCOG.

4.2.3: Public Involvement

Public involvement is an important aspect of a project's development. In addition to being able to share their opinions, local citizens can also be a useful source of funding if they support a project. They can provide donations or vote on taxes that would fund the proposed project. Also, once the project is completed, supporters are more likely to take advantage of the recreational and cultural opportunities provided by it, thus stimulating the economy.

Overall, Chattanooga took large strides with its Vision 2000 plan, largely due to its high degree of community input and support. Also, because the citizens were involved with the majority of decisions, they have a sense of hometown pride. This is exemplified by the millions of dollars of private investment that have flowed into the city. One investor's efforts are described in "The Chattanooga Riverpark" (1998):

> "The Bluff View Arts district, an old Victorian riverfront neighborhood on a hillside near downtown, was renovated by a local developer who has restored the surrounding buildings, and built an indoor and outdoor art gallery; four restaurants; a bed and breakfast that is now housed in three restored buildings; and an executive conference / fine banquet center."

The city of Chattanooga was able to use public funding to encourage private investment and citizen involvement, and the project was very successful as a result.

Public input was also encouraged in Portland when it came to developing a plan for River Renaissance. When city officials took action that residents didn't approve of, the public voiced their objections. For example, the city attempted to rezone protected areas near streams, but it felt resistance due to the new zoning requirements. In order to understand the cause of the objections, city officials visited residents to hear citizens' concerns and reexamined their decisions.

New York City attempted to involve residents of the watershed area in the program, while not inconveniencing them. Compensation was given a number of different ways. First, a subsidy was paid to landowners who incurred additional costs due to best management (environmentally-friendly) processes, which includes activities such as avoiding point and non-point source pollution. Second, additional logging permits were given to logging companies who used environmentally-friendly techniques, such as low-impact logging. Lastly, landowners owning more than 50 acres were given an 80% reduction in property taxes for using best management methods.

Although compensation was provided, many residents of the watershed towns were opposed to having their land purchased by New York City. Thus, the Coalition of Watershed Towns (CWT) was created in hopes of negotiating with New York's city officials. While members of this organization understood the need to protect the land, many residents depended on the land for employment in forestry and farming. They wanted the land acquisition process to be more public, with only those areas providing significant benefits to NYC being purchased. It was also requested that additional funding be provided for programs that protect water quality, such as a residential septic program and town wastewater treatment plants. Eventually, the city and towns came to a compromise: New York City would continue to compensate watershed residents as long as the residents continued to protect water quality. New York City was granted a one-year temporary filtration waiver, called a Filtration Avoidance Determination (FAD), in January 2003, and another 3-year temporary filtration waiver in December 2003 (Wilde, 2006).

The feelings concerning development efforts in Sydney, however, are much more mixed. Although some have praised the green infrastructure created in Sydney, there were several flaws in the development project. First and foremost, there was a lack of public involvement. Much of the information pertaining to the original state of Homebush Bay was withheld, and the public was not allowed input on project decisions. According to Beder (1993), 71% of local residents said they had not received enough information to form an opinion on the project, and 75% were not convinced the proposed

area was safe to live or work in. Effective participation requires forums with power delegated among residents. In Sydney, however, public participation "involved only public information sessions and consultation through the Olympic Environmental Forum and six 'Expert Advisory Panels'" (Lessons, 2000, p.28). Fortunately, these information sessions adequately satisfied residents, eliminating any threat of diminishing the potential economic stimulation. In a survey taken in 1998, only 11% of citizens were dissatisfied with the level of public involvement. Developers also ensured everyone involved was supportive of the environmental initiatives by educating them about proper, environmentally-sound procedures. Overall, however, it is clear that public participation was disregarded at times, with deadlines, profit, and prestige taking precedence ("Lessons," 2000).

The level of public involvement and support varies greatly among the case studies. Chattanooga's Vision 2000 plan was spearheaded by a local organization, giving it a support base from the beginning. New York City didn't adequately consult residents of the watershed, and thus faced opposition from the Coalition of Watershed Towns (CWT). However, city officials negotiated with the CWT until a compromise was found. Portland was in between Chattanooga and New York City. Portland asked for input from residents, but also made some decisions without consulting the public and city officials faced resistance as a result. The Olympic development project in Sydney involved the least amount of public participation. Many citizens were unaware of development plans and were not even convinced the area was environmentally safe.

4.2.4: Outcomes of Projects

The case studies each achieved their own level of success according to their original goals. Chattanooga earned a great deal of recognition for its efforts. It was named one of the most enlightened cities in America by Utne Reader, one of the top ten family vacation destinations by Family Fun magazine, one of the world's great cities, one of the country's best places to live, work, and play by Outside magazine, and one of America's most walkable cities by Walking magazine ("21st Century"). This recognition

has forced other cities to use Chattanooga's redevelopment as a model, both domestically and internationally.

Portland's River Renaissance efforts have not yet been completed; however, there have been very positive thoughts about the project. As Otto, McCormick, and Leccese (2004) observe,

> "If any city is likely to succeed with such a task, it is Portland, a city known for its long history of planning and environmental stewardship. The Willamette was a model for restoration in the 1970's, and it can be again." (p. 147)

The Port of Portland received seven consecutive environmental awards, most recently in 2007. This award, given by the American Association of Port Authorities, is given to one out of 150 public ports in the Western Hemisphere ("Port of Portland"). Portland has won more than any other port in the U.S. Additionally, the city's plans for the waterfront are considered outstanding. Portland recently won an Urban Waterfront Award for its planning efforts. "River Renaissance" describes its award application:

> "[It] represents the evolution of a comprehensive and coordinated initiative for the Willamette River, from vision through evaluation. Most importantly, because River Renaissance combines a compelling philosophy with a robust organizing framework, it will continue to inform Portland's river-related planning efforts in the years to come."

Portland has been very successful in the steps it has taken so far. The question, however, is if the city can maintain its momentum in reviving the waterfront. As Otto et al. observe, "River Renaissance is arguably the most ambitious river revitalization effort in recent U.S. history" (p. 147). Given that project is so large, the city could fail to complete many goals successfully, but their intricate planning will hopefully counteract that possibility; they have been very successful so far, winning numerous awards.

The methods used by New York City in restoring the Catskill and Delaware watersheds were also successful, achieving both ecological and economic goals simultaneously. The watershed restoration provided the city the water purification

services needed, while simultaneously saving $7.5-12 billion dollars over a 10 year period. Additionally, the Catskill watershed was recently under review for a new waiver. On April 13, 2007, the New York Times reported that the U.S. EPA deemed the water safe, and granted the city a 10-year waiver. It will continue to be the largest unfiltered system in the country (Wilde, 2006). As a condition of the waiver, however, New York City was required to set aside $300 million during those 10 years in order to continue protecting the watershed upstate.

With all the positives and negatives accompanying Sydney's Olympic development project, it's not surprising that there have been mixed feelings about the degree of its success. Some of the significant outcomes that have been cited (i.e. Leece, 2001) are the remediation of Homebush Bay; education of policymakers, industry, and the public; demonstration of Ecologically Sustainable Design (ESD) in a large-scale project; and an integrated waste strategy. In addition, the Olympic Village residences all sold above forecasted sale prices, and they are now thought of as state-of-the-art living. Of all the achievements, however, one stands above the rest. Industry was made aware of the positive effects of an environmental approach.

In contrast, opponents of the Sydney project offer their opinions openly. Some argue that Sydney's alleged green measures caused people to overlook serious environmental problems, such as exposure to harmful chemicals in the ground. Environmentalists have argued that private interests were given priority over public well-being. Beder (1993) stated,

> "The absence of public debate and the short-cut, low-cost remediation measures are anything but 'green'. The claim that the 2000 Olympics will be green should be seen in the same light as other green marketing claims, as a superficial attempt to sell a product rather than a genuine attempt at change." (p. 8)

Although the Sydney development project included green design, ESD was not the catalyst behind the project; cost and design took precedence ("Lessons," 2000). The majority of revenue was used to construct and improve sports facilities, and restored

wetlands were perceived as less important as a result. It was also one of the largest paving jobs ever done in Australia. Many have blamed these problems on budget and time constraints, but Willis (2000) attributes it to the "disjuncture between genuine environmental efforts of architects and engineers and feeble commitments by officials that initiated the ESD plans" (p. 4).

The greatest accomplishments of Sydney's development for the 2000 Olympic Games were in construction, transportation, biodiversity and energy conservation, while the greatest shortcomings were in planners' failure to address air, water, and particularly soil quality. "Lessons" (2000) summarizes it as,

> "Those who praise worthwhile outcomes emphasize how ESD principles in Sydney's 'green' Games are incorporated into the facilities design, provide Australian industry with a competitive edge and have generated greater awareness both internationally and domestically of the environment. In contrast, those who raise concerns emphasize the dilution of the planning process, the lack of public participation and the priority given to private over public interests." (p.22)

All the case studies reached their own level of success. Chattanooga improved its air and water quality, and is now a worldwide model for waterfront redevelopments. Portland, although its project is not completed, has won many awards for its planning efforts. New York City has maintained a safe water supply, and was just granted a ten-year waiver. The environmental impact of the development in Sydney is debated. Many commend their ESD principles, while others cite the priority given to private interests over the well-being of the public.

4.3: Potential of the Blackstone Canal Project

The main goal of this project was to determine the feasibility of integrating ecological goals into the existing Blackstone Canal Project. In order to do this, a number of issues relating to feasibility were examined, including the effects of combining economic and ecological goals, potential funding, and public involvement. The four researched case studies were then used to provide supporting evidence as to whether or

not integration of ecological goals into the Blackstone Canal Project would be feasible with regards to each issue. At the end, a recommendation was given regarding the ecological potential of the Blackstone Canal Project.

4.3.1: Integration of Economic and Ecological Goals

The current Blackstone Canal Project has been designed in order to create cultural and economic stimulation in downtown Worcester. As stated in the background, the current goals of the project are to:

1. Tell the Canal District's story
2. Maximize the Canal District's waterfront potential
3. Respect the area's historic fabric
4. Take full advantage of underutilized parcels of land
5. Designate three themed Gateways: Washington, Kelley, and Brosnihan Squares
6. Establish Kelley Square as a new front door to Worcester and the Canal District
7. Organize the plan around the Canal District's squares, unique settings, and water linkages
8. Create a pedestrian and bicycle network to and through the Canal District

(Rizzo Associates et al., 2003)

While the goals do not include ecological goals, it may be possible to integrate ecological goals into this project, as shown in the case studies. Chattanooga, a city long known for its lack of environmental care, was able to stimulate the economy and achieve its goals regarding air and water quality as a result of its Vision 2000 plan. The plan also created regional environmental awareness, and is used as a model for other waterfront redevelopments due to its complete turnaround. The environmentally-conscious city of Portland has also integrated economic and ecological goals into many projects in years past. The current River Renaissance 2001 Project, designed to further restore the Willamette River and its banks, appears promising, having won numerous environmental planning awards.

Unlike in Chattanooga and Portland, New York City's project originated due to an ecological need for water purification services. Thus, achieving ecological goals was given priority over economic goals. The only economic goal for New York City was to provide water purification at the lowest possible cost. Sydney, Australia's Olympic development program had intentions of achieving both economic and ecological goals. Unfortunately, its degree of ecological success has been debated. Due to the prestige of the Olympic Games, it created an international awareness of green development by attempting to conserve species and resources, particularly power and water, and creating a pollution control plan. Conversely, many argue that developers ignored public health when developing the contaminated Homebush Bay area, and therefore were creating a façade in order to host the Olympics and create an inflow of money and tourists.

Worcester and its city officials could use these case studies for ideas of ecological services that could be integrated into the Blackstone Canal Project. For example, while the construction of a canal would create environmental amenities for citizens to enjoy, as in Chattanooga and Portland, it could also provide ecological services. It was shown in Portland that a lack of natural embankments along a waterway seemed to cause problems with regard to water quality and stormwater runoff. Additionally, a shallow canal could cause flood problems when it rains. In Worcester, the edges of the canal could incorporate a more natural setting, creating natural filtering processes as well as helping to control stormwater runoff and flooding.

The canal could also incorporate ideas from the New York City and Sydney cases. While the construction of a canal could not create a watershed large enough or clean enough to provide all of the citizens of Worcester with drinking water, it might be able to incorporate a water feature, similar to the Northern Water Feature in Sydney, which cleanses water for local irrigation purposes. It also may be able to assist the Upper Blackstone Water Pollution Abatement District plant in Millbury with treating sewage. Along with the anticipated population growth resulting from this project, there will be an increased demand for sewage treatment. Currently, however, the Upper Blackstone plant that provides most of Worcester with sewage treatment is experiencing cutbacks and

occasional water shortages (Kotsopoulous, 2006). If the canal could be incorporated into the wastewater treatment system, and provide local businesses and residents with its services, perhaps some of the pressure would be removed from the Upper Blackstone plant.

The anticipated business and residential growth in the Blackstone Canal area could also incorporate power conservation methods. As in Sydney's Olympic Village, if newly constructed buildings use green development principles, power consumption in the area could be reduced dramatically. This could be done, for example, by placing solar panels on roofs and facing buildings in the appropriate direction to best capture solar energy.

The main issue regarding accomplishment of economic and ecological goals appears to be prioritizing. In order to achieve ecological goals, Worcester's city officials must make them a priority, not merely an afterthought. The more successful case studies (Chattanooga, Portland, and New York City) made the environment a very important factor in their development plans. Sydney, on the other hand, had an ulterior motive. Environmental considerations were included as a result of new Olympic site selection guidelines. Homebush Bay probably wouldn't have been remediated if not for the potential of hosting the Olympics, and development would not have included resource conservation and pollution control if they were not included in these guidelines.

4.3.2: Funding

In order to incorporate ecological goals into a project focused mainly on economic and cultural stimulation, additional funding may be required. While some ecologically-minded decisions could cost less, such as creating a natural edge to the canal instead of a concrete edge, others could cost more than if the project aimed to achieve solely economic goals. One example of this is if the canal were to be integrated into the wastewater treatment system. The city would then need to incorporate the technology to treat the water, as well as create a means of transporting the treated water from the canal

to another natural water source. Ultimately, Worcester should be aware of the potential costs that could be incurred due to integration and scope of ecological goals if they choose to integrate them.

The case studies that were researched demonstrated that there are multiple avenues for funding. Chattanooga mainly used taxation and fundraising meetings with the mayor when developing its waterfront. Portland plans on using a mixture of public and private investment. New York City used taxation, bonds, and trust funds. Lastly, Sydney collected funding mainly as a result of Olympic prestige through ticket sales, sponsorships, and broadcast rights. Additionally, Chattanooga, Portland, and Sydney experienced an increase in tourism after projects were completed which increased the flow of money into the city.

Worcester could use numerous methods used previously by the cities in the case studies, one of which is taxation. The city could tax local residents in order to publicly finance the project, as in Chattanooga and New York City. According to Wrenn, Casazza, and Smart (1983), there are a number of different taxation methods that have been used to stimulate private investment in waterfront redevelopment projects. First, property tax incentives eliminate uncertainties to the developer concerning taxes, and also improve cash flow to the developer. Secondly, tax abatement freezes taxes for a limited time in order to encourage development and stabilize businesses in their beginning stages. Next, taxation districts encourage development in a specified area by reducing taxes on existing properties. Lastly, tax increment financing "isolates the additional property tax revenues produced by redeveloping and upgrading deteriorating properties and uses these revenues to repay the development costs (Wrenn et al., 1983, p. 69). If these taxation methods consider and include environmental stipulations, it may be possible to not only stimulate private investment, but also encourage green development. The issue with this approach, however, is ensuring that green development is not merely an afterthought to developers, as in Sydney, but a top priority. Additionally, it could be possible for Worcester to collect funding from the other sources used in the case studies, such as fundraising meetings, bonds, and trust funds.

4.3.3: Public Involvement

Upon examination of the case studies, there appeared to be a correlation between public involvement and success of a project. When citizens are involved in a project, they are more likely to support it, which leads to a number of positive effects. In addition to facilitating the direction of the project according to the desires of local citizens, it can also assist in approving tax raises, provide opportunities for private investment, and help to rejuvenate the economy further. When the public is in support of a project, they are more likely to use the services provided by it once the project is completed.

For example, in Chattanooga, the Vision 2000 program originated due to an organization created by local citizens. Every person who wanted to provide their input on the direction of the project was encouraged to participate. As a result, citizens helped approve tax raises, and provided a large amount of private investment, and Chattanooga became a successful waterfront redevelopment. Portland used the same approach as Chattanooga in its River Renaissance 2001 project and encouraged citizens to participate in the planning process. Additionally, when Portland's city officials felt resistance due to their decisions, they asked opponents for their opinions and adjusted their plans accordingly.

In New York City, the approach was slightly different. While there was enough support within city limits to approve an increase in taxes for five years, the city faced opposition from watershed residents. New York City was buying out property and influencing decisions within watershed towns to the dismay of residents. When the opposers created the Coalition of Watershed Towns, New York City officials negotiated and provided compensation to them in order to make the majority of watershed residents content.

Sydney incorporated very little public input into their project planning. Many citizens were unaware of intended plans; some were not even convinced the development

site was safe for humans. More than 10% were dissatisfied with the level of public involvement. As a result, many were very unhappy, even after the project was completed, and there is still debate about the level of ecological success of the project. While it created international awareness of green development and ecologically sustainable design, its level of safety was questionable.

Overall, the level of public input has a profound effect on the success of a project. Chattanooga incorporated a large amount of public opinion and produced a very successful project. Sydney, on the other hand, had very little public input, and its success has been debated since the project's inception. If Worcester decides to incorporate ecological goals into its project planning, it is important to find a public support base. Having this base could lead to additional funding through taxation, private investment, and an increased interest in the services provided by the project.

4.3.4 Outcomes of Projects

Each city achieved its own level of success with their particular project. Chattanooga's Vision 2000 plan used public and private funding in order to clean the Tennessee River and rejuvenate the economy and tourist industry within the city. Portland's planning efforts have won multiple awards for their environmental initiatives concerning the fluctuating condition of the Willamette River. New York was able to obtain multiple filtration waivers since their attempts to restore the Catskill watershed and saved billions of dollars by using this approach. Finally, Sydney created international awareness of the principles of green development when they received the Olympic bid. While their level of ecological success is debated, they received local public support as a result of their efforts. This is exemplified in the fact that all homes in the Olympic Village sold at or above forecasted sale prices after the Olympics had ended.

Worcester has the potential to integrate ecological services into the Blackstone Canal Project and achieve the same successes as the case studies. It is possible to incorporate ecological services into the urban infrastructure through the methods of green development. If the planning is completed with priority given to both ecological and economic goals, the city can provide these ecological services while further rejuvenating the economy by catering to those who support environmental initiatives. Those individuals could then provide funding, support taxation, and provide their opinions on the direction the project needs to take.

5: Conclusions and Recommendations

The following sections give conclusions about the project and then provide recommendations concerning the potential of the Blackstone Canal Project. First, a general overview of the project's progression and results is given. Then, recommendations are given of how Worcester's officials should proceed if they would like to consider integrating ecological goals into the plans for their city.

5.1: Conclusions

The goal of this research was to determine how a reconstructed Blackstone Canal can provide environmental services for the citizens of Worcester while simultaneously fulfilling its main goal of economic stimulation. In order to accomplish this, a number of objectives were identified.

The first objective was to explain the concept of ecological economics, and how it relates to this project. Ecological economics helps to explain the link between ecology and economics; in order to preserve our natural environment for future generations, we must be careful not to exploit it for the sake of capitalistic ventures.

The next objective was to explain what ecological services are, how they are used, and how they can be incorporated into the urban infrastructure. Ecological services are those services provided to humans by the natural environment. These include water supply and purification, waste treatment, air purification, recreation, culture, and others. They are integrated into the urban infrastructure through a method known as green development. Green development ensures that people will be provided the ecosystem services needed while the natural environment is conserved.

The third objective was to find and research case studies which have integrated ecological goals into their economically-based projects. Waterfront redevelopment (ecological amenities) projects were researched first, and a total of 22 were discovered.

They were then narrowed down to two on the basis of their concern with environmental goals, the original purpose of the waterfront, and city population. This left Chattanooga, Tennessee and Portland, Oregon to be researched further. While researching these waterfront redevelopments, New York (an ecological economics case study) and Sydney (a green development case study) were discovered and added to the list of case studies for further research.

The four case studies were then researched according to their (1) ecological and economic goals, (2) funding, (3) level of public involvement, and (4) outcome. These four aspects of the project were then examined in terms of their applicability to Worcester. It was found that attainment of a variety of ecological goals is possible, ranging from air and water purification to restoration of natural filtering systems to power conservation. It was also feasible to simultaneously rejuvenate the economy. Many funding methods were used in the projects, for example: taxation, private donations, bonds, and trust funds. These could potentially be used in Worcester to finance the Blackstone Canal Project. There were also differing levels of public support among the case studies. It was shown that a higher level of public involvement generally leads to a more successful project. Finally, the outcomes of the case studies show that it is possible to collect enough funding and public support to create a project which concerns itself with ecological goals, and make the project successful.

If Worcester could use these case studies as examples of how to integrate ecological services into the proposed canal project, it could rejuvenate the economy further than anticipated while providing ecological services the city needs. However, if city officials do not plan carefully and make environmental initiatives a priority, they could end up losing more money.

5.2: Recommendations

In order to determine if integration of ecological goals into the Blackstone Canal Project is a wise decision, Worcester should first determine if the city is in need of

ecological services or if the need will arise soon due to population growth. Next, it is important to find a support base. A number of citizens currently support the economically-minded Blackstone Canal Project. City officials would need to determine if this same group would also support ecological goals, and if not, they would need to find citizens to support their ideas and voice their opinions. Lastly, Worcester would need to determine where their funding would come from, such as public funding, private funding, or funding from city, state, and federal governments. There are also a number of different methods to derive funding and the city needs to figure out which works best for their situation. They could raise taxes, create bonds or trust funds, ask wealthy citizens to donate, or use another method.

If Worcester decides there is a need for ecological services within the city, and choose to integrate these services into the Blackstone Canal Project, the city will need to ensure that ecological goals are made a priority. Worcester will also need to make sure that the provisioning of these services can be maintained and that the citizens' needs are adequately met.

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Appendix I – Initial Case Studies

City	Type of Project	City Location	City Population (2000 U.S. Census Data)	Type of Waterway	Name of Waterway (or region as applicable)	Original Purpose
Worcester, MA	N/A	Northeast	172,648	Canal	Blackstone Canal	Commerce
Baltimore, MD	Ecological Amenities	Northeast	651,154	Harbor	Inner Harbor	Industrial
Boston, MA	Ecological Amenities	Northeast	589,141	Harbor	Inner Harbor/Union Whar	Shipbuilding, Fishing
Boston, MA	Ecological Amenities	Northeast	589,141	Harbor	Inner Harbor/Navy Yard	Naval Shipyard
Charleston, SC	Ecological Amenities	Southeast	96,650	River	Cooper River	Steamboat Business
Chattanooga, TN	Ecological Amenities	Southeast	155,554	River	Tennessee River	Industrial
Chicago, IL	Ecological Amenities	Midwest	2,896,016	River	Chicago River	Industrial
Detroit, MI	Ecological Amenities	Midwest	951,270	River	Rouge River	Industrial
Greenwich, CT	Ecological Amenities	Northeast	61,101	River	Mianus River	Industrial/Residential
Hartford, CT	Ecological Amenities	Northeast	121,578	River	Connecticut River	Industrial
Los Angeles, CA	Ecological Amenities	West	3,694,820	River	Los Angeles River	Industrial
Napa, CA	Ecological Amenities	West	72,585	River	Napa River	Recreational
New York, NY	Ecological Economics	Northeast	8,143,197	N/A	N/A	Residential, Commercial
New York, NY	Ecological Amenities	Northeast	8,143,197	River	Bronx River	Industrial
Portland, OR	Ecological Amenities	Northwest	529,121	River	Willamette River	Industrial, Furniture Manu.
Providence, RI	Ecological Amenities	Northeast	173,618	Rivers	See "Other Relevant Info"	Industrial, Mills
Redmond, WA	Ecological Amenities	Northwest	45,256	River	Sammamish River	Recreational
Salem, MA	Ecological Amenities	Northeast	40,407	Harbor	Pickering Wharf	Coal, Oil, Gas Storage
San Diego, CA	Ecological Amenities	West	1,223,400	Bay	San Diego Bay	Industrial, Military
San Jose, CA	Ecological Amenities	West	894,943	River	Guadalupe River	
St. Louis, MO	Ecological Amenities	Southeast	348,149	River	Mississippi River	Economic (Trading Post)
Stamford, CT	Ecological Amenities	Northeast	117,083	Harbor	Long Island Sound	Light Industrial
Suisun City, CA	Ecological Amenities	West	26,118		Suisun City Waterfront	Residential
Sydney, Australia	Green Infrastructure	Australia	4,069,093*	Bay	Homebush Bay	Industrial
Tacoma, WA	Ecological Amenities	Northwest	193,556	River/Harbor	City Waterway	Industrial

*Census Data for Sydney's population found at:
http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/5EAD1F774418A95ACA25728E0014C5A8/$File/32180_statistical_local_areas.xls

City	Current Use	Year of Redevelopment	Funding Sources Private or Public	Other Relevant Info
Worcester, MA	TBD	N/A	N/A	
Baltimore, MD	Offices, Residential, Tourism	1964	40 million TC	Evolved in increments, Harborplace 1978
Boston, MA (1)	Tourism, Residential	1978	13 million TC	New Sewage System, Faneuil Hall, Quincy Market
Boston, MA (2)	Historic, Tourism, Residential	1976	Pub-30mil, Pri-600mil	
Charleston, SC	Commercial, Residential	1983	16milTC, 2 Private Don, Dept. of Interior	
Chattanooga, TN	Economic, Tourism, Envir.	1987		EPA's "dirtiest city" 1969
Chicago, IL	Recreation, Envir., Economy	1999		
Detroit, MI	Ecological	1990		Doubled fines for illegal dumping
Greenwich, CT	Residential	1977	Private-6,850,000, Pub-0	
Hartford, CT	Economic	1998	57milTC	Previously called "best landscaped sewer"
Los Angeles, CA	Economic, Ecological	1990's	2 State Bond Measures	
Napa, CA	Ecological	1998		
New York, NY (1)	Ecological, Economic	1990's	Taxation, Trust Funds	
New York, NY (2)	Recreation, Commercial	1974		Bronx River Restoration Project
Portland, OR	Commercial, Environmental	1975/2000	Bonds	RiverPark
Providence, RI	Retail, Tourism	1982	1.12bil, 200mpb, 900mpr	Providence, Woonasquatucket, and Moshassuck Rivers
Redmond, WA	Recreation, Environmental	2000		
Salem, MA	Commercial, Resid., Theater	1977		
San Diego, CA	Commercial	1962		Seaport Village - $14million, 3.5 mil tourists/yr
San Jose, CA	Ecological, Economic, Resid.	2004		Guad. Riv. Park Plan, Downtown GR Flood Control Proj.
St. Louis, MO	Residential, Retail, Institutional	1975	Pri-200mil, Pub-1.6mil	Fire destroyed riverfront
Stamford, CT	Office, Retail	1977		Hurricane destroyed shipyard
Suisun City, CA	Residential (Population Boom)	1990	Bonds-68, CADOT-.5	1988-Last in "quality of life" in Bay Area
Sydney, Australia	Economic, Ecological	1990's	Public	
Tacoma, WA	Commercial, Economic	1974	Pub-10, Pri-8	No new industry allowed, sanitary sewers installed

Appendix II – Selected Case Study Summary

The sections following on the next four pages contain summaries of each individual selected case: Chattanooga, Portland, New York City, and Sydney. Each summary contains information on the five main topics that were researched further: (1) economic goals, (2) ecological goals, (3) funding, (4) public support, and (5) results (economic and ecological).

6.1: Chattanooga, Tennessee

1. Economic Goals: Rejuvenate economy struggling from an industrial decline

2. Ecological Goals: Reverse the damage done to the environment (air, land, and water) by once-thriving industries.

3. Funding: Hotel/motel tax ($56 million), fundraising meetings ($36 million)

4. Public Support: Project ideas came directly from residents of Chattanooga through the Chattanooga Venture's first program: Vision 2000

5. Results:
    a. Ecological
        i. Met air quality standards within 5 years
        ii. Cleaned and restored Tennessee River
        iii. Created large amounts of open space
        iv. Created regional environmental awareness
    b. Economic
        i. Stimulated private investment by use of public funding
        ii. Developed low-income housing
        iii. Created 1,381 permanent jobs and 7,300 temporary jobs
    c. Recognition – Chattanooga was named:
        i. One of the most enlightened cities in America by Utne Reader
        ii. One of the top ten family vacation destinations by Family Fun magazine
        iii. One of the country's best places to live, work, and play by Outside magazine
        iv. One of America's most walkable cities by Walking magazine

6.2: Portland, Oregon

1. Economic Goals: Maintain or improve economic condition of harbor, embrace the river as Portland's "front yard," and create an inviting waterfront district

2. Ecological Goals: Clean and restore the Willamette River

3. Funding: Mixture of public and private. Many sources to be determined.

4. Public Support: Public input encouraged in planning.

5. Results:
    a. Most ambitious river revitalization effort in recent U.S. history
    b. Seven consecutive environmental awards
    c. Urban Waterfront Award

6.3: New York, New York

1. Economic Goals: Provide safe drinking water at the lowest possible cost.

2. Ecological Goals: Provide New York City with safe drinking water according to revised EPA standards by restoring the Catskill watershed.

3. Funding:
    a. Taxation: Additional 9% on water bills for five years.
    b. New York City bonds
    c. Trust Funds
        i. Catskill Fund for the Future - $60 million
        ii. NYC Trust Fund - $240 million for projects in the Catskills, $70 million for projects in the Delaware watersheds.
        iii. City used $472 million to upgrade current water-related facilities.

4. Public Support: Supported decision to restore the Catskills. Construction of a filtration plant would have meant an 18% increase in taxes. Twofold

5. Results:
    a. Saved $7.5-12 billion dollars
    b. Granted a 10-year filtration waiver on April 13, 2007
    c. Largest unfiltered system in the United States
    d. Forced to maintain water quality due to reviews every five years.

6.4: Sydney, Australia

1. Economic Goals: Host the 2000 Olympic Games, increase tourism, and stimulate the economy.

2. Ecological Goals: Protect endangered species, incorporate ecologically-sustainable design concepts in order to conserve power and water, and develop a pollution control system for the Olympic site.

3. Funding:
    a. Collected due to prestige of Olympic Games through tickets, sponsorship, etc.
    b. Sydney Organizing Committee for the Olympic Games (SOCOG):
        i. Broadcast rights: $1,132 million
        ii. Sponsorship: $686 million
        iii. Licensing: $73 million
        iv. Tickets: $616 million
        v. Other: $325 million

4. Public Support:
    a. Supporters:
        i. Praise the remediation of Homebush Bay
        ii. Increased awareness of the concepts of ecologically sustainable design
    b. Opposition:
        i. Stresses the potential health issues that could arise from tourists visiting a previously contaminated site
        ii. Believe that cost and design took precedence over environmentally-friendly methods of development.

5. Results:
    a. All residences in Olympic Village sold at or above forecasted sale prices.
    b. $3 billion in new business investments, including almost $2 billion in post-Games sports infrastructure and contracts.
    c. Over $6 billion in tourism spending in 2001
    d. Strong collaboration with private investors and developers.
    e. Increased awareness of environmental industry and potential of ecologically-sustainable design.